Cutting Parameter Recommended Table

Materials				WC drilling insert series grade apllication range & cutting parameter recommended													
ISO	Material classification	Tensile strength (N/mm^2)	Hardness (HB)	AP301U			AP351U			AC301P			Feed (mm/rev)				
				PVD caoted			PVD caoted			CVD caoted							
				P15-35			P30-45			P25-40							
				M15-35			M30-45			-							
				-			-			-							
				-			S 30-45			-							
				-			-			-							
				-			-			-							
				Feed (mm/rev)													
				Min	Med	Max	Min	Med	Max	Min	Med	Max	ϕ16mm ~ ϕ20 mm	ϕ20.5mm ~ ϕ25mm	ϕ25.5mm ~ 30 mm	ϕ31mm ~ ϕ41 mm	ϕ41mm ~ ϕ58 mm
				Cutting speed (m/min)									WCMT 030204E-DU/DG	WCMT 040204E-DU/DG	WCMT 050308E-DU/DG	WCMT 06T308E-DU/DG	WCMT 080408E-DU/DG
P	Non-alloyed steel	<600	<180	260	240	224	220	185	150	200	175	150	0.04-0.065	0.07-0.09	0.07-0.10	0.08-0.11	0.09-0.13
		<950	<280	250	210	170	200	170	140	190	162.5	135	0.05-0.07	0.09-0.09	0.07-0.10	0.08-0.11	0.09-0.13
	Alloyed steel	700-950	200-280	240	200	160	190	160	130	180	150	120	0.05-0.09	0.065-0.14	0.08-0.16	0.10-0.18	0.10-0.20
		950-1200	280-355	210	170	130	170	130	90	160	130	100	0.04-0.07	0.065-0.11	0.07-0.14	0.09-0.15	0.10-0.18
		1200-1400	355-415	170	140	110	160	120	80	140	110	80	0.04-0.065	0.05-0.9	0.07-0.10	0.08-0.12	0.09-0.13
M	Duplex stainless steel	778	230	260	200	140	180	135	90	-	-	-	0.04-0.07	0.065-0.11	0.08-0.14	0.08-0.11	0.09-0.13
	Austenitic stainless steel	675	200	220	170	120	120	65	60	-	-	-	0.04-0.065	0.065-0.10	0.08-0.12	0.08-0.10	0.08-0.11
	Precipitation-hardening stainless steel	1013	300	180	140	100	90	65	40	-	-	-	-	-	-	-	-
K	Grey cast iron	700	220	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Nodular cast iron	880	260	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Malleable cast iron	800	250	-	-	-	-	-	-	-	-	-	-	-	-	-	-
S	Fe-based alloy	943	280	-	-	-	40	30	20	-	-	-	-	-	-	-	-
	Co-based alloy	1076	320	-	-	-	35	25	15	-	-	-	-	-	-	-	-
	Ni-based alloy	1177	350	-	-	-	35	25	15	-	-	-	-	-	-	-	-
	Ti-alloy	1262	370	-	-	-	40	30	20	-	-	-	0.05-0.10	0.06-0.11	0.07-0.12	0.08-0.13	0.08-0.14
N	Aluminum	260	75	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Aluminum alloy	447	130	-	-	-	-	-	-	-	-	-	-	-	-	-	-
H	Hardened steel	-	50-60HRC	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Chilled cast iron	-	55HRC	-	-	-	-	-	-	-	-	-	-	-	-	-	-

*The recommended cutting conditions always refer to general conditions. These cutting conditions should be adjusted according to the practical machine rigidity, tools, workpiece clamping and coolants.

ACHTECK

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Technical Guide

CUTTING TOOL CATALOGUE

Technical guide

Grade Conversion Table

Turning

ISO classification	Material classification	ACHTECK	COROMANT	ISCAR	KENNAMETAL	KORLOY	KYOCERA	MITSUBISHI	SECO	SUMITOMO	TAEGUTEC	TUNGALOY	WALTER	ZCC
P	P10	AC150P	GC4315 GC4215	IC8150	KCP10 KC9110	NC3010 NC3015	CA515 CA5515	MC6015 UE6110	TP1500 TP1501	AC810P AC700G	TT8115	T9115 T9015	WPP10S WPP10	YBC152 YBC151
	P20	AC250P	GC4325 GC4225	IC8250	KCP25 KC9215	NC3220 NC3120	CA525 CA5525	MC6025 UE6020	TP2500 TP2501	AC8025P AC820P	TT8125	T9125 T9025	WPP20S WPP20	YBC251 YBC252
	P30	AC350P	GC4335 GC4235	IC8350	KCP30 KCP40 KC9040	NC3030 NC500H	CA5535	MC6035 UE6035	TP3500	AC830P	TT8135 TT8020*	T9135 T9035	WPP30S WPP30	YBC351 YBC352
M	M10	AP100S*	GC2015 GC1105*	IC907* IC807*	KCM15 KC5510* KCU10*	PC8110*	CA6515 PR1305* PR1310* PR1215*	MC7015 US7020 VP10RT* MP9005*	TS2000* TH1000* CP200*	AC610M AC6020M AC510U*	TT9215 TT5080*	AH110* AH905* AH8005*	WSM10* WSM10S*	YBM151 YBG102* YBG105*
	M20	AP301M*	GC2025 GC1115* GC15*	IC908* IC887*	KCM25 KC5525* KCU25*	NC9025 PC5300*	CA6525 PR930* PR1025* RP1225* PR1325*	MC7025 VP15TF* MP9015*	TM2000 CP500*	AC620M AC6030M AC520U*	TT9225 TT9080*	T6120 T6020 AH120* AH630* AH8015*	WSM20* WSM20S* WMP20S	YBM251 YBG202* YBG212* YBG205*
K	K10	AC100K	GC3205 GC3005	IC5005	KCK05	NC6205	CA4505 CA4010	MC5005 UC5105	TK1001 TK1000	AC405K AC410K	TT7005	T505	WKK10S WAK10	YBD052
	K20	AC150K ACK15A	GC3210 GC3215	IC5010	KCK15 KC9315	NC6110	CA4515 CA415	MC5015 UC5115	TK2001 TK2000	AC415K AC700G	TT7310 TT7015	T5115 T515	WKK20S WAK20	YBD152C YBD152
S	S10	AP100S*	GCS05F GC1105* GC1115*	IC807* IC907*	KCU10* KC5510* KC5010	PC8110*	PR1305* PR1310*	VP10RT* MP9005*	TH1000* TH1500* TS2000*	AC510U*	TT5080*	AH110* AH905* AH8005*	WSM10*	YBG102* YBG105*
	S20	AP301M*	GC15* GC1115*	IC808* IC908*	KCU20* KC5525* KC5025*	PC5300*	PR1025* PR1225* PR1325*	VP15TF* MP9015*	CP500*	AC520U*	TT9080*	AH120* AH8015*	WSM20*	YBG212* YBG202* YBG205*
N	N10	AW100K	H10	IC20	K68 K313	H01	KW10	HTI10	KX	H1	K10	TH10	WK1	YD101

"*" PVD coating grades

Turning Chip Breaker Conversion Table

Negative turning insert

ISO classification	Application	ACHTECK	COROMANT	ISCAR	DURACARB	KENNAMETAL	KORLOY	KYOCERA	MITSUBISHI	SECO	SUMITOMO	TAEGUTEC	TUNGALOY	VALENITE	WALTER	ZCC
P	Finishing	PB1		SF		FF, FS	HU, VL	DP, GP, PP VF	FH	FF1, FF2	FA FL	FA, FS FX	TF, 01 ZF	F2	FP5	SF
			QF	NF, F3P	41	FP LF, FN	VG, VF VQ	XF XP HQ	LP SH FY	MF2	SU SE	FG FM	NS, 11 TS, AS TSF		NF4	NF DF
	Semi-finishing	PB3	PF, XF		43		VB, VC, HC	CQ, PQ CJ	SA		LU	FC, FT			NS6	NM
	Medium machining	PL5	K						ES	UX	GX, HM	VF, DNUX FS	S			
					52	MN	HC	GS		MR3		MC	ASW		MP3	PM
			QM, 23, LC SM, -NGP, 23 SR, SMR	PP TF	42	MS, MP UP, P, -NGP RP	HA VP3 VM	XQ, XS A3, AH MS, MU	MJ, SY MS GJ	MF4, MF5 M5, MR3, MR4	UP, GX, AG EG, EX, UP MU	ML MP	P HMM, SA	M2	NMS, NMT NRS, NRT	
		PC3	PM, XM QM	M3P VL	45	P	VM HS, GS	PG PS	MP, MV MA	MF3 MF5, M3	GE GU	PC	TM	M2	MP5 NM4	PM
		PD3	HM, XMR	GN	46	MP RP, RM	HM, GM	HS CS			UX, UG	MT		M3	NM6 NM9	DM
		PC4		MG-	53	UN	B25	MG-C	MG-	M4 MR4	UZ	MG-	33, 37, 38 DM, MG-		MG-	MG-
	Roughing machining	PD5	PR	NR, R3P		RN	HR, GR	PT, GT PH, HT	MH GH, RP	M5 MR7, M6	ME MU, MX	RT	TH	R3	NR4, RP5	DR
	Heavy machining	PD8	PR			RM		PX				RX			NRF	
			QR MR	R3P NM		MR, RP	GH	HX	HZ	R6, RR9 R4, R5, 37 RR6	MP HG HP	RH	TRS 57	R6	NR6	
		PC9	HR, 31			RH	VT		HCS HX, HBS	R8, 56, 57 R7	HF HU	HT, HD	65 TU		NRR	ER HDR
		PD9					VH		HV, HDS, HXD		HW	HY, HZ				
M	Finishing	MB2	MF	SF, F3M	41	FP	HA, VP2	MQ, GU	FS, LM	MF1	SU	EA, SF	SF	F5	NF4	EF
	Medium machining	MC3	MM	M3M	42	MP, UP	GS, HS	MS, MU	MS, GM, MA	MF4	EX, UP, GU	EM	SS, S		NM4	EM
	Roughing machining	MC4	MR	R3M	45	RP	VM	HU	RM	MR6, MF5	MU, HM	ET	SM	M5	NR4 NRS	ER
K	Medium machining	PC4		MG-	53	RP		C	MG-, GK	M5		MG-	MG-		NM5, RK5	MG-
	Roughing machining	KC4 KD5	KR			UN	GR	ZS, GC	GX, RK	MR7	GZ	KT RT	CH		RK7	DR
S	Finishing	MB2	SF	SF		FS	VP1	MQ	FJ	MF1	EF	EA, SF		F5	NF4	NF
	Medium machining	SC3	SGF SM, -NGP, 23 SR, SMR	PP TF	42	MS UP, P, -NGP RP	VP2 VP3 VM	MS, MU	MJ MS GJ	M1 MF4, MF5 M5, MR3, MR4	SU EG, EX, UP MU	ML MP, SU, MK	HMM, SA	M2	NFT NMS, NMT NRS, NRT	NM
	Roughing machining	MC4	MR	R3M	45	RP	VM	HU	RM	MR6,MF5	MU,HM	ET	SM	M5	NR4 NRS	ER

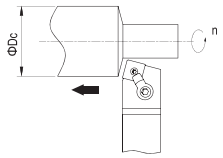
Turning Chip Breaker Conversion Table

Positive turning insert

ISO classification	Application	ACHTECK	COROMANT	DURACARB	ISCAR	KENNAMETAL	KORLOY	KYOCERA	MITSUBISHI	SECO	SUMITOMO	TAEGUTEC	TUNGALOY	VALENITE	WALTER	ZCC
P M K	Finishing		PF, UF		38, PF	UF, 11, GM	VL, VF, HFP	XP GK, GP, DP VF	FV	FF1	LU FP	FA FX	01, PF, PSF		PF4, PF5	SF HF
		PB1 PC2						CF, GF GQ CK	SMG		FC	SA	JS			
			UM XF	51	SM 16, GT-	FP LF	VF HMP, C05	XQ GX	SQ, SV	F1	FK SU SC, SK	FG		PM3 PM4	PS5	HM
	Semi-finishing	PC2	PM	41		MP		HQ				PC FM	PSS PS			EF EM
	Medium machining	KC2	XM PR, UR XR	52	14, 17 19, MT-	MF	C25	MT-	MQ, MV MT-G	F2	SF, MU	MT	PM	PM5	PM5 E47, MT-	HR
N	Semi-finishing	NC2	AL	AU	AF, AS	HP	AK, AR	AH	AZ	AL	AW, AG	FL	AL	IL	PM2	LH

Turning Machining Formula

● Cutting speed



$$Vc = \frac{\pi * Dc * n}{1000} \ (m/min)$$

Vc:Cutting speed(m/min) π: ≈3.14
Dc:Workpiece diameter(mm) n:Spindle speed(rev/min)

● Feed speed

$$Vf = f * n \ (mm/min)$$

Vf:Cutting speed(mm/min) f:Feed rate(mm/rev)
n:Spindle speed(rev/min)

● Chip thickness

$$h = f * sinkr \ (mm)$$

h:Chip thickness(mm) f:Feed rate(mm/rev)

● Chip width

$$b = \frac{ap}{sinkr} \ (m/min)$$

b:Chip width(mm) ap:Axial depth of cut (mm)

● Chip area

$$A = h * b = ap * f \ (mm^2)$$

A:Chip area(mm^2) ap:Axial depth of cut (mm)
f:Feed rate(mm/rev)

● Cutting force

$$Fc = Kc * ap * f \ (N)$$

Fc:Cutting force(N) Kc:Unit cutting force(N/mm^2)
ap:Axial depth of cut (mm) f:Feed rate(mm/rev)

● Cutting power

$$Pmot = \frac{Kc * Vc * ap * f}{60000 * \eta} \ (KW)$$

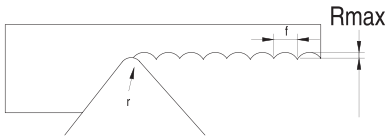
Pmot:Cutting power(KW) Kc:Unit cutting force(N/mm^2)
Vc:Cutting speed(m/min) ap:Axial depth of cut (mm)
f:Feed rate(mm/rev) η :Mechanical efficiency

● Chip removal

$$Q = ap * f * Vc \ (cm^3/min)$$

Q:Chip removal(cm^3/min) ap:Axial depth of cut (mm)
f:Feed rate(mm/rev) Vc:Cutting speed(m/min)

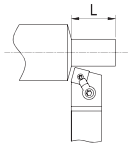
● Theoretic surface roughness



$$Rmax = \frac{f^2}{8 * r} * 1000 \ (um)$$

Rmax:Theoretic surface roughness (um)
f:Feed rate(mm/rev) r:Corner radius (mm)

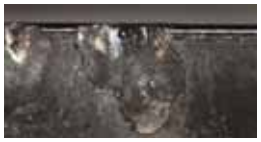
● Work time



$$Tc = \frac{L}{f * n} \ (min)$$

Tc:Work time f:Feed rate(mm/rev)
n:Spindle speed(rev/min) L: Working length(mm)

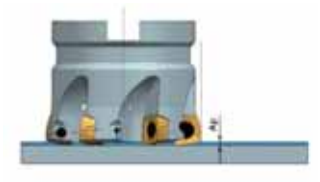
Turning Insert Normal Failtures & Solutions

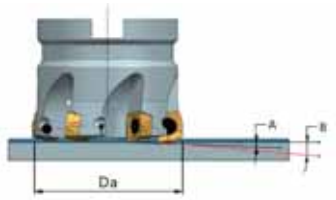
Failtures	Pic.	analysis	Solution
Flank wear		• Tool materials too soft • Excessive cutting speed • Less clearance angle • Less feed rate • Insufficient cooling	• Choosing high wear-resistance insert grade • Reduce cutting speed • Enlarge clearance angle • Increase feed rate
Crater wear		• Tool materials too soft • Excessive cutting speed • Excessive feed rate	• Choosing high wear-resistance insert grade • Reduce cutting speed • Reduce feed rate • Increasing the flow of coolant
Chipping		• Tool materials too hard • Less cutting strength	• Choosing tougher grade • Enhancing cutting edge strength
Deformation		• Tool materials too soft • Over stronge cutting edge • Excessive cutting depth & feed rate • Insufficient cooling	• Choosing high wear-resistance insert grade • Reduce cutting speed reduce cutting depth & feed rate • Choosing good thermal conductivity grade • Increasing the flow of coolant
Built-up edge		• Less cutting speed • Cutting edge not sharp • Unsuitable grade • Insufficient cooling	• Increase cutting rate • Choosing sharp geometry • Choosing less adhesion grade • Increasing the flow of coolant
Mechanical wear		• Excessive feed rate and cutting depth • Vibration	• Choosing tougher grade • Enlarge lead angle • Choosing bigger corner radius • Change to strong rigidity holder
Thermal cracking		• Excessive cutting heat change of edges	• Choosing dry cutting or adequate cooling • Choosing tougher grade
Peripheral wear		• Excessive feed rate & cutting speed • Tool materials too soft	• Choosing high wear-resistance tool grade • Enlarge rake angle leads to sharp edge • Reduce cutting speed
Coating peeling		• Sticky chip on the cutting edge • Chip evacuation failure	• Enlarge rake angle leads to sharp edge • Use chip breaker with bigger space

Milling Grades Conversion Table

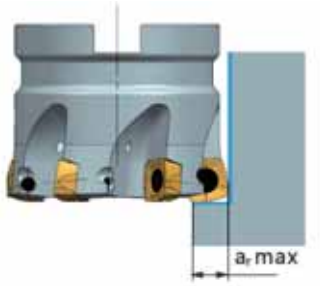
ISO classification	ACHTECK	CORMANT	ISCAR	KENNAMETAL	KORLOY	KYOCERA	MITSUBISHI	SECO	SUMITOMO	TAEGUTEC	TUNGALOY	WALTER
P	AP301U AC301P	GC4220 GC4230	IC950	KC522M KC635M	PC3600 PC3500 PC3535 PC3525	PR630 PR660 PR730	VP15TF	MP1500 MP2500 T250M		TT7080 TT7030	T3130 AH330	WKP25 WAM10 WAM20
P	AP351U	GC1030 GC4240	IC808 IC908	KC522M KC635M KC725M	PC5300 NC5330 PC9530	PR9925 PR830	VP15TF VP20RT	F30M MP3000	ACP2000	TT9080 TT9030	AH120 AH725 AH730 GH330	WAM30
P	AP401U	GC1040	IC830 IC330 IC928	KC735M KC935M	PC3545		VP30RT FH7020X F7030	F40M MP2500	ACP300 ACZ350	TT8020 TT7800 TT8080	AH140 T3130 AH130	WKP235 WXP45 WSP45
M S	AP301U	GC1030 GC2030	IC808 IC908	KC635M	PC5300 NC5330 PC9530	PR730 PR830 PR925 PR1025	VP15TF	MP2500 F30M	ACP2000	TT9300 TT9080	T3130 AH725 AH120	WAM30 WXM35
M S	AP351U	GC2040 S40T	IC830 IC330 IC928	KC7725M	PC3545 PC5300	PR1225 PR905	VP30RT MP9030 F7030	F40M MM4500 MS2500	ACP300 EH20Z EH520Z	TT8020 TT8080	AH130 AH140 SH730	WXM35 WSM35 WSP45
K	AC301K AP351K	GC3220 GC4220	IC810 IC910	KCK15 KC520M	PC6510 PC215K PC5300	PR905 PR510 PR610	MC5020 VP15TF MP8010	MK2050 MK2000 MK3000	ACK2000 ACK3000 ACZ310	TT6080	T1115 AH120 GH110	WKP25 WKP35

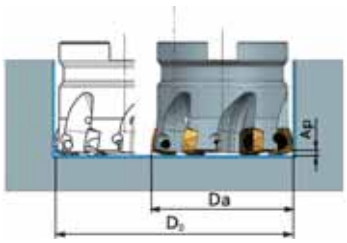
High Feed Cutter AHM15-XD Application Information

Face milling	Maximum milling depth ap(mm)		
	apmax	XD..0904	XD..1205
		1.5	2.5

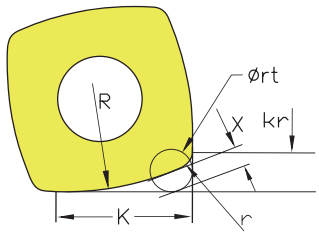
Ramping	Maximum bevel			
	Da (mm)	XD..0904		XD..1205	
		Maximum bevel A	Maximum bevel B	Maximum bevel A	Maximum bevel B
	25	2.80°	6.30°	-	-
	32	1.50°	5.00°	-	-
	40	0.80°	2.70°	-	-
	52	-	-	0.8°	2.7°
	63	-	-	0.6°	1.8°
	66	-	-	0.45°	1.8°
	100	-	-	0.32°	1.45°
	125	-	-	0.24°	1.06°

A=Maximum bevel angle of full flat contact B= Maximum bevel of full contact + radius

Plunging	Maximum milling depth a_r (mm)		
	Da(mm)	XD..0904	XD..1205
	25	6.0	Maximum bevel A
	32	6.0	-
	40	6.0	-
	50	6.0	-
	52	-	9.0
	63	-	9.0
	66	-	9.0
	80	-	9.0
	100		9.0
	25	-	9.0

Helical ramping	Diameter range of hole that can be milled in one pass (mm)				
	Da (mm)	XD..0904		XD..1205	
		D_o min (mm)	D_o max (mm)	D_o min (mm)	D_o max (mm)
	25	30	50	-	-
	32	51	64	-	-
	40	67	80	-	-
	50	87	100	-	-
	52	-	-	87.2	104
	63	-	-	109.2	126
	66	-	-	115.2	132
	80	-	-	143.2	160
	100	-	-	183.2	200
	25	-	-	233.2	250

Programming Information

Helical ramping							
	Indexable insert	R	r	rt	k	kr	x
	XD..090408	17	0.8	2.0	6.5	1.9	1.47
	XD..120508	22.8	0.8	2.5	8.4	2.4	1.00
	XD..120512	20	1.2	3.0	8.3	2.8	0.86
	XD..120520	20	2.0	3.0	8.0	3.4	0.90
	When programmed with the theoretical tool radius "rt", the maximum deviation shown above is produced with the final contour. Minor deviations that occur only in rounded corners can be corrected by other tools in subsequent process.						

Milling General Recommendation

● Cutting speed

$$Vc = \frac{\pi * Dc * n}{1000} \ (m/min)$$

Vc:Cutting speed(m/min) π: ≈3.14
Dc:Cutter diameter(mm) n:Spindle speed(rev/min)

● Spindle speed

$$n = \frac{1000 * Vc}{\pi * Dc} \ (rev/min)$$

Vc:Cutting speed(m/min) π: ≈3.14
Dc:Cutter diameter(mm) n:Spindle speed(rev/min)

● Feed speed

$$Vf = fz * n * Z \ (mm/min)$$

Vf:Feed speed(mm/min) fz:Feed per tooth(mm/z)
n:Spindle speed(rev/min) Z:Number of teeth

● Feed rate per rev.

$$fz = \frac{Vf}{n * Z} \ (mm/z)$$

fz:Feed rate per rev.(mm/z) Vf:Feed speed(mm/min)
n:Spindle speed(rev/min) Z:Number of teeth

● Feed rate per rev.

$$f = \frac{Vf}{n} \ (mm/rev)$$

f:Feed rate per rev.(mm/rev) Vf:Feed speed(mm/min)
n:Spindle speed(rev/min)

● Time of cut

$$Tc = \frac{L}{Vf} \ (min)$$

Tc:Time of cut(min) L:Length of feed(mm)
Vf:Feed speed(mm/min)

● Horse power

$$Hp = \frac{Pmot}{0.75}$$

Hp:Horse power Pmot:Cutting power(KW)

● Power demand

$$Pmot = \frac{ap * ae * Vf * Kc}{6 * 10^7 * \eta} \ (KW)$$

Pmot:Cutting power(KW) ap:Cutting depth ae:Cutting width
Kc:Unit cutting force(N/mm²) η :Machine efficiency coefficient(0.7-0.95)

● Average chip thickness

$$hm = \frac{114.7 * fz * sink * (ae/Dc)}{\psi s} \ (mm)$$

hm:Average chip thickness fz:Feed per tooth(mm/z)
ae:Cutting width Dc:Cutter diameter(mm) ψs:Pressure angle

● Feed force

Cutter in the center site

$$\psi s = 2 * \arcsin\left(\frac{ae}{Dc}\right) \ [^\circ]$$

Cutter in excentric site

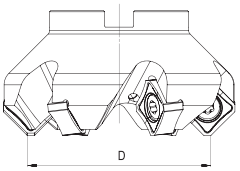
$$\psi s = 90^\circ + \arcsin\frac{ae-(Dc/2)}{(Dc/2)} \ [^\circ]$$

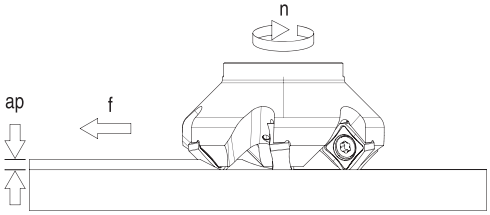
ψs:Pressure angle ae:Cutting width
Dc:Cutter diameter(mm)

● Chip removal

$$Q = \frac{ap * ae * Vf}{1000} \ (cm^3/min)$$

Q:Chip removal(cm³/min) ap:Cutting depth
ae:Cutting width Vf:Feed speed(mm/min)





Drilling General Recommendation

● Cutting speed

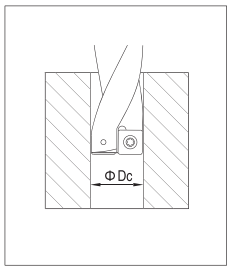
$$Vc = \frac{\pi * Dc * n}{1000} \ (m/min)$$

Vc:Cutting speed(m/min) π:≈3.14
Dc:Drill diameter(mm) n:Spindle speed(rev/min)

● Spindle speed

$$n = \frac{1000 * Vc}{\pi * Dc} \ (rev/min)$$

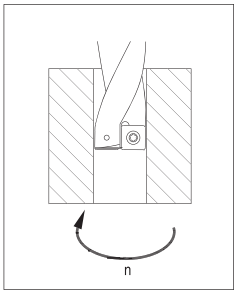
Vc:Cutting speed(m/min) π: ≈3.14
Dc:Drill diameter(mm) n:Spindle speed(rev/min)



● Feed speed

$$Vf = fz * n * Z \ (mm/min)$$

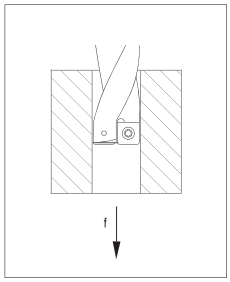
Vf:Feed speed(mm/min) fz:Feed per tooth(mm/z)
n:Spindle speed(rev/min) Z:Number of teeth



● Feed per tooth

$$fz = \frac{Vf}{n * Z} \ (mm/z)$$

fz:Feed per tooth(mm/z) Vf:Feed speed(mm/min)
n:Spindle speed(rev/min) Z:Number of teeth



● Feed rate per rev.

$$f = \frac{Vf}{n} \ (mm/rev)$$

f:Feed rate per rev.(mm/rev) Vf:Feed speed(mm/min)
n:Spindle speed(rev/min)

● Chip removal

$$Q = \frac{Vf * \pi * Dc^2}{4 * 1000} \ (cm^3/min)$$

Q:Chip removal(cm^3/min) Vf:Feed speed(mm/min)
π: ≈ 3.14 Dc:Drill diameter(mm)

● Horsepowe

$$Hp = \frac{Pmot}{0.75}$$

Hp:Horsepowe Pmot:Cutting power(KW)

● Power demand

$$Pmot = \frac{Q * Kc}{60000 * \eta} \ (KW)$$

Pmot:Cutting power(KW) Q:Chip removal(cm^3/min)
Kc:Unit cutting force(N/mm^2)
η:Machine efficiency coefficient (0.7-0.95)

● Torque

$$Mc = \frac{Dc^2 * Kc * f}{8000} \ (N*m)$$

Mc:Torque Dc:Drill diameter(mm)
Kc:Unit cutting force(N/mm^2) f:Feed rate per rev.(mm/rev)

● Feed force

$$Ff = 0.63 * \frac{f * Dc * Kc}{2} \ (N)$$

Ff:Feed force f:Feed rate per rev.(mm/rev)
Dc:Drill diameter(mm) Kc:Unit cutting force(N/mm^2)

● Cutting thickness

$$h = fz * sink \ (mm)$$

h:Cutting thickness(mm) fz:Feed rate(mm/rev)

Hardness Conversion Table

Brinell Hardness 10 ball load 3000Kg		Micro Vickers Hardness HV	Rockwell Hardness				Shore's Hardness	Tensile Strength (approximate) kgf/mm
Master ball	WC ball HB		A scale 60kgf diamond brale HRA	B scale 100kgf 1/16in ball HRB	C scale 150kgf diamond brale HRC	D scale 100kgf diamond brale HRD		
-	-	1865	92.0	-	80	-	-	-
-	-	1787	91.5	-	79	-	-	-
-	-	1710	91.0	-	78	-	-	-
-	-	1633	90.5	-	77	-	-	-
-	-	1556	90.0	-	76	-	-	-
-	-	1478	89.5	-	75	-	-	-
-	-	1400	89.0	-	74	-	-	-
-	-	1323	88.5	-	73	-	-	-
-	-	1245	88.0	-	72	-	-	-
-	-	1160	87.0	-	71	-	-	-
-	-	1076	86.5	-	70	-	-	-
-	-	1004	86.0	-	69	-	-	-
-	-	940	85.6	-	68.0	76.9	97	-
-	-	920	85.3	-	67.5	76.5	96	-
-	-	900	85.0	-	67.0	76.1	95	-
-	767	880	84.7	-	66.4	75.7	93	-
-	757	860	84.4	-	65.9	75.3	92	-
-	745	840	84.1	-	65.3	74.8	91	-
-	733	820	83.8	-	64.7	74.3	90	-
-	722	800	93.4	-	64.0	73.8	88	-
-	712	-	-	-	-	-	-	-
-	710	780	83.0	-	63.3	73.3	87	-
-	698	760	82.6	-	62.5	72.6	86	-
-	684	740	82.2	-	61.8	72.1	-	-
-	682	737	82.2	-	61.7	72.0	84	-
-	670	720	81.8	-	61.0	71.5	83	-
-	656	700	81.3	-	60.1	70.8	-	-
-	653	697	81.2	-	60.0	70.7	81	-
-	647	690	81.1	-	59.7	70.5	-	-
-	638	680	80.8	-	59.2	70.1	80	-
-	630	670	80.6	-	58.8	69.8	-	-
-	627	667	80.5	-	58.7	69.7	79	-
-	601	640	79.8	-	57.3	68.7	77	-
-	578	615	79.1	-	56.0	67.7	75	-
-	555	591	78.4	-	54.7	66.7	73	210
-	534	569	77.8	-	53.5	65.8	71	202
-	514	547	76.9	-	52.1	64.7	70	193
	495	528	76.3		51.0	63.8	68	186
-	477	508	75.6	-	49.6	62.7	66	177
-	461	491	74.9	-	48.5	61.7	65	170
-	444	472	74.2	-	47.1	60.8	63	162
429	429	455	73.4	-	45.7	59.7	61	154
415	415	440	72.8	-	44.5	58.8	59	149
401	401	425	72.0	-	43.1	57.8	58	142
388	388	410	71.4	-	41.8	56.8	56	136
375	375	396	70.6	-	40.4	55.7	54	129
363	363	383	70.0	-	39.1	54.6	52	124
352	352	372	69.3	(110.0)	37.9	53.8	51	120
341	341	360	68.7	(109.0)	36.6	52.8	50	115
331	331	350	68.1	(108.5)	36.6	51.9	48	112
321	321	339	67.5	(108.0)	34.3	51.0	47	108
311	311	328	66.9	(107.5)	33.1	50.0	46	105
302	302	319	66.3	(107.0)	32.1	49.3	45	103
293	293	309	65.7	(106.0)	30.9	48.3	43	99
285	285	301	65.3	(105.5)	29.9	47.6	-	97
277	277	292	64.6	(104.5)	28.8	46.7	41	94

Hardness Conversion Table

Brinell Hardness 10 ball load 3000Kg		Micro Vickers Hardness HV	Rockwell Hardness				Shore's Hardness	Tensile Strength (approximate) kgf/mm
Master ball	WC ball HB		A scale 60kgf diamond brale HRA	B scale 100kgf 1/16in ball HRB	C scale 150kgf diamond brale HRC	D scale 100kgf diamond brale HRD		
269	269	284	64.1	(104.0)	28	45.9	40	91
262	262	276	63.6	(103.0)	27	45.0	39	89
255	255	269	63.0	(102.0)	25	44.2	38	86
248	248	261	62.5	(101.0)	24	43.2	37	84
241	241	253	61.8	100	23	42.0	36	82
235	235	247	61.4	99	22	41.4	35	80
229	229	241	60.8	98.2	21	40.5	34	78
223	223	234	-	97.3	(18.8)	-	-	
217	217	228	-	96.4	(17.5)	-	33	74
212	212	222	-	95.5	(16.0)	-	-	72
207	207	218	-	94.6	(15.2)	-	32	70
201	201	212	-	93.8	(13.8)	-	31	69
197	197	207	-	92.8	(12.7)	-	30	67
192	192	202	-	91.9	(11.5)	-	29	65
187	187	196	-	90.7	(10.0)	-	-	63
183	183	192	-	90	(9.0)	-	28	63
179	179	188	-	89	(8.0)	-	27	61
174	174	182	-	87.8	(6.4)	-	-	60
170	170	178	-	86.8	(5.4)	-	26	58
167	167	175	-	86	(4.4)	-		57
163	163	171	-	85	(3.3)	-	25	56
156	156	163	-	82.9	(0.9)		-	53
149	149	156	-	80.8		-	23	51
143	143	150	-	78.7		-	22	50
137	137	143	-	76.4		-	21	47
131	131	137	-	74		-	-	46
126	126	132	-	72		-	20	44
121	121	127	-	69.8		-	19	42
116	116	122	-	67.6		-	18	41
111	111	117	-	65.7		-	17	39

Material Conversion Table

ISO	Country and standard										
	China	International	Germany	U.S.A.	U.K.		France	Sweden	Italy	Spain	Japan
	GB	DIN	W.-nr	AISI/SAE	BS	EN	AFNOR	SS	UNI	UNE	JIS
P	Structural steel										
	15	C15	1.0401	1015	080M15	-	CC12	1350	C15C16	F.111	-
	20	C22	1.0402	1020	050A20	2C	CC20	1450	C20C21	F.112	-
	35	C35	1.0501	1035	060A35	-	CC35	1550	C35	F.113	-
	45	C45	1.0503	1045	080M40	-	CC45	1650	C45	F.114	-
	55	C55	1.0535	1055	070M55	-	-	1655	C55	-	-
	60	C60	1.0601	1060	080A62	43D	CC55	-	C60	-	-
	Y15	9SMn28	1.0715	1213	230M07	-	S250	1912	CF9SMn28	11SMn28	SUM22
	-	9SMnPb28	1.0718	12L13	-	-	S250Pb	1914	CF9MnPb28	11SMnPb28	SUM22L
	-	10SPb20	1.0722	-	-	-	10PbF2	-	CF10Pb20	10SPb20	-
	-	35S20	1.0726	1140	212M36	8M	35MF4	1957	-	F210G	-
	Y13	9SMn36	1.0736	1215	240M07	1B	S300	-	CF9SMn36	12SMn35	-
	-	9SMnPb36	1.0737	12L14	-	-	S300Pb	1926	CF9SMnPb36	12SMnP35	-
	55Si2Mn	55Si9	1.0904	9255	250A53	45	55S7	2085	55Si8	56Si7	-
	-	60SiCr7	1.0961	9262	-	-	60SC7	-	60SiCr8	60SiCr8	-
	15	Ck15	1.1141	1015	080M15	32C	XC12	1370	C16	C15K	S15C
	40Mn	40Mn4	1.1157	1039	150M36	15	35M5	-	-	-	-
	25	Ck25	1.1158	1025	-	-	-	-	-	-	S25C
	35Mn2	36Mn5	1.1167	1335	-	-	40Mn5	2120	-	36Mn5	SMn438(H)
	30Mn	28Mn6	1.117	1330	150M28	14A	20M5	-	C28Mn	-	SCMn1
	35Mn	Cf35	1.1183	1035	060A35	-	XS38TS	1572	C36	-	S35C
	Ck45	45	1.1191	1045	080M46	-	XC42	1672	C45	C45K	S45C
	55	Ck55	1.1203	1055	070M55	-	XC45	-	C50	C55K	S55C
	50	Cf53	1.1213	1050	060A52	-	XC48TS	1674	C53	-	S50C
	60Mn	Ck60	1.1221	1060	080A62	43D	XC60	1678	C60	-	S58C
	-	Ck101	1.1274	1095	060A96	-	-	1870	-	-	SUP4
	-	X120Mn12	1.3401	-	Z120M12	-	X120M12	-	XG120Mn12	X120Mn12	SCMnH/1
	GCr15	100Cr6	1.3505	52100	534A99	31	100C6	2258	100Cr6	F.131	SUJ2
	-	15Mo3	1.5415	ASTM A204Gr.A	1501-240	-	15D3	2912	16Mo3KW	16Mo3	-
	-	16Mo5	1.5426	4520	1503-245-420	-	-	-	16Mo5	16Mo5	-
	-	14Ni6	1.5622	ASTM A350LF5	-	-	16N6	-	14Ni6	15Ni6	-
	-	X8Ni9	1.5662	ASTM A353	1501-509; 510	-	-	-	X10Ni9	XBNi09	-

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	GB	DIN	W.-nr	AISI/SAE	BS	EN	AFNOR	SS	UNI	UNE	JIS
P	Structural steel										
	-	12Ni19	1.5680	2515	-	-	Z18N5	-	-	-	-
	-	36NiCr6	1.5710	3135	640A35	111A	35NC6	-	-	-	SNC236
	-	14NiCr10	1.5732	3415	-	-	14NC11	-	16NiCr11	15NiCr11	SNC415 (H)
	-	14NiCr14	1.5752	34153310	655M13655A12	36A	12NC15	-	-	-	SNC815 (H)
	-	36CrNiMo4	1.6511	9840	816M40	110	40NCD3	-	38CrNiMo4 (KB)	35CrNiMo4	-
	-	21NiCrMo2	1.6523	8620	850M20	362	20NCD2	2503	20NiCrMo2	20NiCrMo2	SNCCM220 (H)
	-	40NiCrMo2	1.6546	8740	311-Type7	-	-	-	40NiCrMo2 (KB)	40NiCrMo2	SNC240
	40CrNiMoA	34CrNiMo6	1.6582	4340	817M40	24	35NCD6	2541	35CrNiMo6 (KB)	-	-
	-	17CrNiMo6	1.6587	-	820A16	-	18NCD6	-	-	14CrNiMo1	-
	15Cr	15Cr3	1.7015	5015	523M15	-	12C3	-	-	-	SCr415(H)
	35Cr	34Cr4	1.7033	5132	530A32	18B	32C4	-	34Cr4(KB)	35Cr4	SCr430(H)
	40Cr	41Cr4	1.7035	5140	530M40	18	42C4	-	41Cr4	42Cr4	SCr440(H)
	40Cr	42Cr4	1.7045	5140	-	-	-	2245	-	42Cr4	SCr440
	18CrMn	16MnCr15	1.7131	5115	(527M20)	-	16MC5	2511	16MnCr15	16MnCr15	-
	20CrMn	55Cr3	1.7176	5155	527A60	48	55C3	-	-	-	SUP9(A)
	30CrMn	25CrMo4	1.7218	4130	1717CDS110	-	25CD4	2225	25CrMo4 (KB)	55Cr3	SCM420; SCM430
	35CrMo	34CrMo4	1.7220	4137;4135	708A37	19B	35CD4	2234	35CrMo4	34CrMo4	SCM432; SCRRM3
	40CrMoA	41CrMo4	1.7223	4140;4142	708M40	19A	42CD4TS	2244	41CrMo4	41CrMo4	SCM440
	42CrMo 42CrMnMo	42CrMo4	1.7225	4140	708M40	19A	42CD4	2244	42CrMo4	42CrMo4	SCM440(H)
	-	15CrMo5	1.7262	-	-	-	12CD4	2216	-	12CrMo4	SCM415(H)
	-	13CrMo44	1.7335	ASTMA182F11; F12	1501-620Gr.27	-	15CD3.5; 15CD4.5	-	14CrMo44	14CrMo45	-
	-	32CrMo12	1.7361	-	722M24	40B	30CD12	2240	32CrMo12	F.124.A	-
	-	10CrMo910	1.7380	ASTMA182F.22	1501-622Gr.31;45	-	12CD9;10	2218	12CrMo9,10	TU.H	-
	-	14MoV63	1.7715	-	1503-660-440	-	-	-	-	13MoCrV6	-
	50CrVA	50CrV4	1.8159	6150	735A50	47	50CV4	2230	50CrV4	51CrV4	SUP10
	-	41CrAlMo7	1.8509	-	905M39	41B	40CAD6,12	2940	41CrAlMo7	41CrAlMo7	-
	-	39CrMoV139	1.8523	-	897M39	40C	-	-	36CrMoV12	-	-

Material Conversion Table

ISO	Country and standard										
	China	International	Germany	U.S.A.	U.K.		France	Sweden	Italy	Spain	Japan
	GB	DIN	W.-nr	AISI/SAE	BS	EN	AFNOR	SS	UNI	UNE	JIS
P	Tool steel										
	T10	C105W1	1.1545	W.110	-	-	Y1105	1880	C98KU C100KU	F.515 F.516	-
	T12A	C125W	1.1663	W.112	-	-	Y2120	-	C120KU	(C120)	SK20
	GCr15	100Cr6	1.2067	L3	BL3	-	Y100C6	-	-	100Cr6	-
	Cr12	X210Cr12	1.2080	D3	BD3	-	Z200Cr12	-	X210Cr13KU X250Cr12KU	X210Cr12	SKD1
	4Cr5MoVSi	X40CrMoV5 1	1.2344	H13	BH13	-	Z40CDV5	2242	X35CrMoV05KU X40CrMoV51KU	X40CrMoV5	SKD61
	Cr6WV	X100CrMoV5 1	1.2363	A2	BA2	-	Z100CDV5	2260	X100CrMoV51KU	X100CrMoV5	SKD12
	CrWMo	105WCr6	1.2419	-	-	-	105WC13	2140	10WCr6 107WCr5KU	105WCr5	SKS31 SKS2 SKS3
	Cr12W	X210CrW12	1.2436	-	-	-	-	2312	X215CrW12 1KU	X210CrW12	SKD2
	5CrNiMo	45WCrV7	1.2542	S1	BS1	-	-	2710	45WCrV8KU	45WCrSi8	-
	3Cr2W8V	X30WCrV93 X30WCrV93KU	1.2581	H21	BH21	-	Z30WCV9	-	X28W09KU X30WCrV9 3KU	X30WCrV9	SKD5
	Cr12MoV	X165CrMoV 12	1.2601	-	-	-	-	2310	X165CrMoW12KU	X160CrMoV12	SKD11
	5CrNiMo	55NiCrMoV6	1.2713	L6	-	-	55NCDV7	-	-	F.250.S	SKT4
	V	100V1	1.2833	W210	BW2	-	Y1105V	-	-	-	SKS43
	W6Mo5Cr4V2Co5	S6-5-2-5	1.3243	-	-	-	Z85WDKCV	2723	HS6-5-2-5	HS6-5-2-5	SKH55
	W18Cr4VCo5	S18-1-2-5	1.3255	T4	BT4	-	Z80WKCV 10-05-04-01	-	X78WCo1805KU	HS18-1-1-5	SKH3
	W6Mo5Cr4V2	S6-5-2	1.3343	M2	BM2	-	Z85WDCV 06-05-04-02	2722	X82WMo0605KU	HS6-5-2	SKH9
	-	S2-9-2	1.3348	M7	-	- Z -	Z100WCWV 09-02-04-02	2782	HS2-9-2	HS2-9-2	-
	W18Cr4V	S18-0-1	1.3355	T1	BT1	-	Z80WCV 18-04-01	-	X75W18KU	HS18-0-1	SKH2
	W6Mo5Cr4V3	S6-5-3	-	M3	-	-	-	-	-	-	SKH52
	-	-	-	M42	BM42	-	-	-	-	-	SKH59

Material Conversion Table

ISO	Country and standard										
	China	International	Germany	U.S.A.	U.K.		France	Sweden	Italy	Spain	Japan
	GB	DIN	W.-nr	AISI/SAE	BS	EN	AFNOR	SS	UNI	UNE	JIS
M	Stainless steel										
	0Cr13; 1Cr12	403	1.4000	403	403S17	-	Z6C13	2301	X6Cr13	F.3110	SUS403
	-	-	1.4001	-	-	-	-	-	-	F.8401	-
	1Cr13	410	1.4006	410	410S21	56A	X12Cr13	2302	X12Cr13	F.3401	SUS410
	1Cr17	430	1.4016	430	430S15	60	X8Cr17	220	X8Cr17	F.3113	SUS430
	2Cr13	410	1.4021	40	S62	56B;56C	X20C13	-	X20C13	F.3401	SUS410
	-	-	1.4027	-	420C29	56B	-	-	-	-	SCS2
	4Cr13	-	1.4034	-	420S45	56D	X40Cr14	2304	X40Cr14	F.3405	SUS420J2
	1Cr17Ni2	431	1.4057	431	431S29	57	X16CNi16	2321	X16CNi16	F.3427	SUS431
	Y1Cr17	430F	1.4104	430F	-	-	X10CrS17	2383	X10CrS17	F.3117	SUS430F
	1Cr17Mo	434	1.4113	434	434S17	-	X8CrMo17	2325	X8CrMo17	-	SUS434
	-	-	1.4313	-	425C11	-	-	-	-	-	SCS5
	-	-	1.4408	-	316C16	-	-	-	-	F.8414	SCS14
	4Cr9Si2	HW3	1.4718	HW3	401S45	52	X45CrSi8	-	X45CrSi8	F.322	SUH1
	0Cr13Al	405	1.4724	405	403S17	-	X10CrAl12	-	X10CrAl12	F.311	SUS405
	Cr17	430	1.4742	430	430S15	60	X8Cr17	-	X8Cr17	F.3113	SUS430
	8Cr20Si2Ni	HNV6	1.4757	HNV6	443S65	59	X80CrSiNi20	-	X80CrSiNi20	F.320V	SUH4
	2Cr25N	446	1.4762	446	-	-	X16Cr26	2322	X16Cr26	-	SUH446
	Austenitic stainless steel										
	0Cr18Ni9	X5CrNi1810	1.4301	304	304S15	58E	Z6CN18.09	2332	X5CrNi1810	F.3551 F.3541; F.3504	SUS304
	1Cr18Ni9MoZr	X10CrNiS189	1.4305	303	303S21	58M	Z10CNF18.09	2346	X10CrNiS18.09	F.3508	SUS303
	0Cr19Ni10	X2CrNi1911	1.4306	304L	304S12	-	Z2CN18.10	2352	X2CrNi18.11	F.3503	SCS19
	-	G-X6CrNi189	1.4308	-	304C15	-	Z6CN18.10M	-	-	-	SCS13
	Cr17Ni17	X12CrNi177	1.4310	301	-	-	Z12CN17.07	2331	X12CrNi1707	F.3517	SUS301
	-	X2CrNiN1810	1.4311	304LN	304S62	-	Z2CN18.10	2371	-	-	SUS304LN
	0Cr19Ni9	X5CrNi189	1.4350	304	304S31	58E	Z6CN18.09	-	X5CrNi1810	-	SUS304
	0Cr17Ni11Mo2	X5CrNi Mo1712	1.4401	316	316S16	Z6CND 17.11	1.4401	2347	X5CrNiMo1712	F.3543	SUS316
	00Cr17Ni13Mo2	X2CrNi MoN17133	1.4429	316LN	-	-	Z2CND17.13	2375	-	-	SUS316LN
	0Cr27Ni12Mo3	X2CrNi Mo18143	1.4435	316L	316S12	-	Z2CDN17.13	2353	X2CrNiMo1713	-	SCS16
	00Cr19Ni13Mo3	X2CrNi Mo17133	1.4438	317L	317S12	-	Z2CND19.15	2367	X2CrNiMo18.16	-	SUS317L
	-	X8CrNiMo275	1.4460	329L	-	-	-	2324	-	-	SUS329L; SCH11; SCS11